

Conservation and Transformation of Energy

PS-6 The student will demonstrate an understanding of the nature, conservation, and transformation of energy.

PS-6.5 Explain how objects can acquire a static electric charge through friction, induction, and conduction.

Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Key Concepts:

Static charge: Electron, Proton

Charging by friction, induction, conduction

Previous/Future knowledge: Students have not previously studied static charge.

In the 4th grade students classified materials as either conductors or insulators of electricity (4-5.8).

In the 6th grade students identified the sources and properties of heat, solar, chemical, mechanical, and electrical energy (6-5.1). In Physical Science students expand the concept of electrical energy.

Students are introduced to the concepts of protons and electrons and their electrical properties.

Students will use the understanding of these subatomic particles to explain how objects acquire a static electric charge through friction, induction, and conduction.

It is essential for students to understand that

- All matter is made up of atoms with three types of particles: protons, neutrons, and electrons. Two of the particles in atoms are electrically charged.
 - The protons, which are tightly held in the nucleus, are positively charged.
 - The electrons, which move around outside the nucleus, are negatively charged.
 - Atoms normally have the same number positive charges that they do negative charges. The effects of these charges cancel out and the object will have no net charge.
- *Static electric charge* is the result of transfer of electrons. The electrons in the atoms can be removed from the atom and moved onto something else.
 - When an object loses electrons, it will have more protons than electrons and will have a net positive charge.
 - When an object gains electrons, it will have more electrons than protons and will have a net negative charge.
- Like charges repel each other. Positives charges repel other positives charges, and negative charges repel other negative charges.
- Opposite charges attract. Negative and positive charges exert an attractive force on each other.
- Objects can be charged by:
 - *Friction:*
 - When one object is rubbed against another, sometimes electrons leave one object and stick to the other leaving both objects charged.
 - The object that loses electrons will get or have a net positive charge, and the object that gains electrons will get or have a net negative charge.
 - *Conduction:*
 - Electrons can be transferred from one object to another by touching.
 - When a charged object touches another object some charge will transfer to the other object.

Conservation and Transformation of Energy

PS-6 The student will demonstrate an understanding of the nature, conservation, and transformation of energy.

- * If the charged object is negative, some of the electrons will leave the negatively charged object and travel to the neutral object leaving both objects with a negative charge.
- * If the charged object is positive, some of the electrons will leave the neutral object and travel to the positively charged object leaving both objects with a positive charge.
- Only the electrons are transferred in solid objects.
- Objects charged by conduction will have the same charge as the object charging it and therefore will repel it.
- *Induction:*
 - Objects can be charged by bringing a charged object near a neutral object.
 - If a charged object is brought near a neutral object the charged object will attract unlike charges in the neutral object and repel like charges in the neutral object.
 - Electrons will move in the neutral object and leave the side nearest the charged object charged with a charge that is opposite the charging object. (Only electrons can move in a solid object.)
 - * If the charged object is negative, the electrons in the neutral object will be repelled leaving the side nearest the charged object with a positive charge. If the neutral object is grounded, electrons are repelled into the ground. If the ground is removed the previously neutral object will be left with a residual positive charge.
 - * If the charged object is positive, the electrons in the neutral object will be attracted and move towards the positive charge leaving the side nearest the charged object with a negative charge. If the neutral object is grounded electrons are pulled from the ground. If the ground is removed, the previously neutral object will be left with a residual negative charge.
 - After an object is charged by induction, it will have the opposite charge of the charging object and will attract it.

It is not essential for the students to give specific examples of things that will charge positively or negatively by friction.

Assessment Guidelines:

The objective of this indicator is to explain how objects can acquire a static charge, therefore, the primary focus of assessment should be to construct a cause and effect model relating how friction, conduction, and induction cause static charge.

In addition to explain, assessments may require that students

- Compare how objects become positively and negatively charged;
- Infer effects of interactions of charges and charged objects;
- Summarize major points about how objects acquire static charge;
- Exemplify situations involving charged objects and how they are charged;
- Recall that static electric charge is the result of transfer of electrons.